TEN GREAT INVENTIONS

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WE THINK the airplane is a modern invention. Yet Leonardo da Vinci outlined the principles of heavier-than-air flying machines in the Fifteenth Century.

Da Vinci was unable to develop his plane because he lacked the machinery to build it.

Many great inventions have been put aside for long periods because machines that could cut and form metal parts accurately and in quantities had not yet been invented.

The world began to enjoy the fruits of inventive genius when machine tools were developed that would work in metal in the same way that a carpenter's tools work in wood. With machine tools for turning, drilling, planing, grinding, and milling — the "Five Basic Arts" of removing metal — there dawned the machine age, providing mechanical conveniences in quantities never dreamed of in the age of hand tools.

The following stories describe ten great inventions which were introduced shortly after the invention of basic machine tools.

As is true with most inventions, each of the ten described herein is credited to one individual as "the" inventor. It should be borne in mind, however, that in the background of many inventions is the work of more than one man. Though many of these men are virtually forgotten today, all of us have profited by what they gave.

Edmund Cartwright

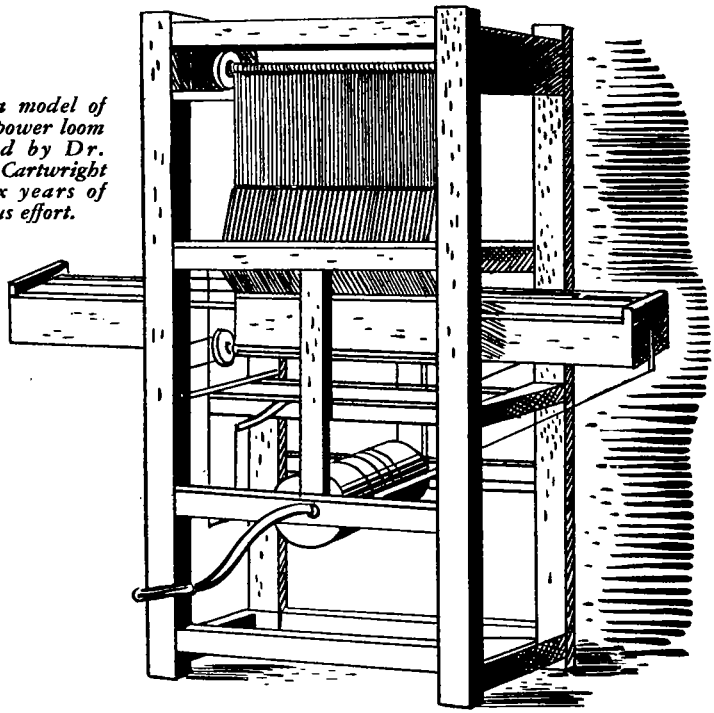
BACK IN 1784 cloth was woven by hand in private homes. Usually everyone in the family worked at it, hunched over their looms day and night. The work was slow and there was never enough cloth. This scarcity made cloth so expensive few people could afford more than one suit or dress at a time.

One night Dr. Edmund Cartwright was having dinner with a group of textile men from Manchester, England. They talked about the spinning "Jenny," an invention that turned out thread so fast hand weaving could not keep up with it.

Dr. Cartwright believed it possible to weave cloth by machinery. His friends laughed at him. They said weaving was too complicated for that.

Dr. Cartwright, who was born in 1743 in Nottinghamshire, had trained for the ministry, had written poetry and articles for magazines, but had never invented anything. The skepticism of the textile men was a challenge.

He concentrated day and night on weaving with machinery. As he paced to and fro in his home, muttering to himself and throwing his arms from side to side, his children would watch him and



This is a model of the first power loom invented by Dr. Edmund Cartwright after six years of continuous effort.

whisper: "Father is thinking of weaving. Now he's throwing the shuttle."

Dr. Cartwright always did a great deal to make life easier and better for those around him. He had studied medicine just to help the poor in his parish. He was loved by everyone, and his efforts to invent a weaving machine were followed with keen interest by all who knew him.

It took him six years to create a power loom that worked. In 1790 he built a weaving factory of 500 looms in Manchester. Almost overnight the high regard people had for Dr. Cartwright turned to resentment.

Hand weavers saw in his machines a threat to their livelihood. They were afraid they would lose their jobs. An angry mob surrounded the factory. They fought

for two days, killing two men and wounding many others. They finally burned down the mill and smashed the looms.

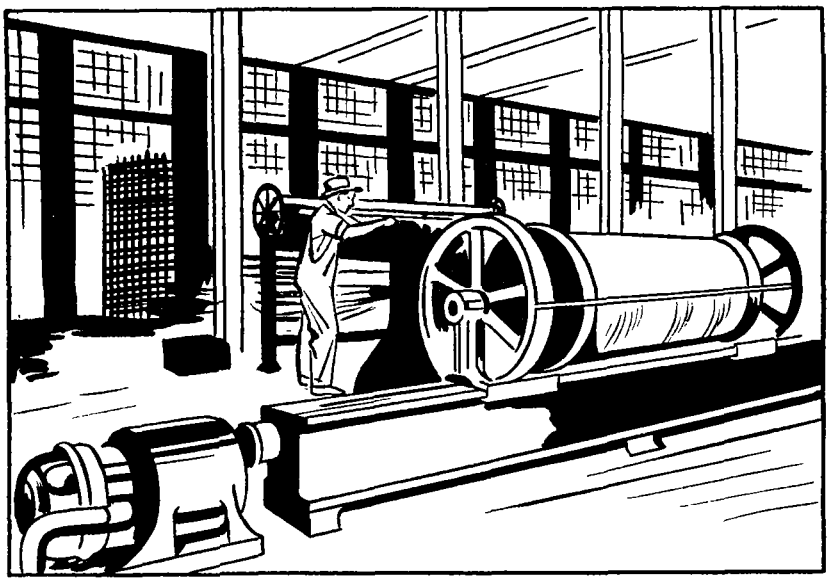
Dr. Cartwright had spent a fortune on his invention and got nothing from it until after 1809, when the British Parliament granted him £10,000, which just about covered his expenses.

Weaving machinery continued to be attacked by workers for a long time.

Yet the power looms brought wealth and prosperity. Cloth was more abundant. As weaving machinery improved, wages, hours and working conditions improved.

Between 1830 and 1914 the number of workers brought into the textile industry in England alone increased 2½ times while the population only doubled.

In the United States, the number of wage earners in the textile industry has increased from 253,000 in 1870 to 1,082,602 in 1939.



A modern power loom, capable of producing almost infinite varieties of patterns and weaves.

Elias Howe, Jr.

EACH NEW invention which speeds up a process calls for another invention.

When improvements in weaving machinery made cloth plentiful, people in Cambridge, Massachusetts, in 1839 began to wonder if hand sewing could keep up with the growing population's demand for a second and third dress or suit.

One day a visitor in a machine shop made the remark: "Some day someone is going to invent a sewing machine and make a fortune."

Curly-headed Elias Howe, a machinist, overheard this prophecy. It haunted him for several years. One day he decided that he, his wife and three children weren't getting anywhere on his nine dollars a week and he went to work on the invention.

The only machine in use at the time made a chain stitch that pulled out easily and was good only for basting.

In Howe's mind a lock-stitch machine took shape, one in which a needle would carry a thread through the cloth, catch the thread on the other side, and lock it.

In May, 1845, Howe finished his machine and sewed two woolen suits on it. Then he invited several

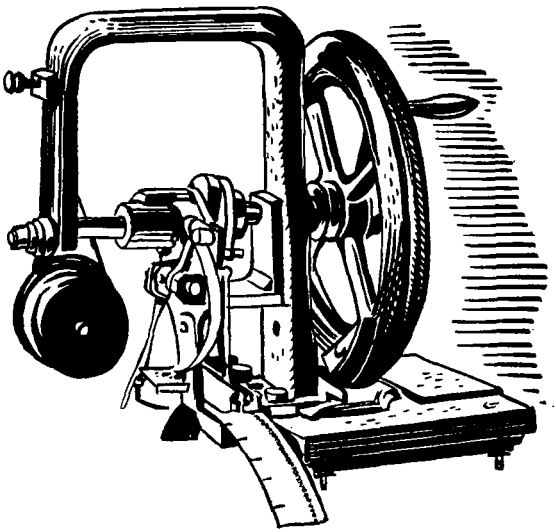
tailors to try it, but they refused.

"If it is put to use, we'll be beggars," they objected.

Howe set up a shop and advertised that he would sew seams. The little machine, contained in a box one and one half cubic feet in volume, sewed 250 stitches a minute, and was an easy winner in a contest with five fast hand workers, but no one wanted to buy it. Manufacturers feared it would be "dangerous to make a change."

Another difficulty arose. Workers in clothing shops organized to prevent the introduction of the machine. They staged the famous "sewing machine riots," breaking into factories and smashing the machines. They said the machines "took the bread from the mouths of the poor."

To prove how far wrong those early rioters were: the sewing machine has made it possible for the average woman in this country to buy four or more new dresses each year in addition to the clothing made in homes on some 20 million sewing machines from 69 million patterns. In 1944 it helped give employment to more than one



Faster than five fast hand sewers, was the first sewing machine, invented in 1845 by Elias Howe.

In addition to clothing made on 20 million machines in American homes, modern sewing machines give employment to more than one million persons in the needle trades.

million Americans making clothing, hats, bags, upholstering, draperies and other products.

If Howe could visit one of our modern clothing plants today, he'd be astonished at the speed and efficiency his machine has acquired. He would see two to 36 needles running at once, making rows of cording, tucking, shirring, basting, felling and embroidery, making stitches up to 5,000 a minute,

He'd see wonderful circular, cylindrical and other odd-shaped attachments for sewing sleeves, trouser legs, hats, bags and shoes; buttonhole machines that cut holes, work edges, tack ends and trim the threads from as many as 6,000 buttonholes a day.

Eli Whitney

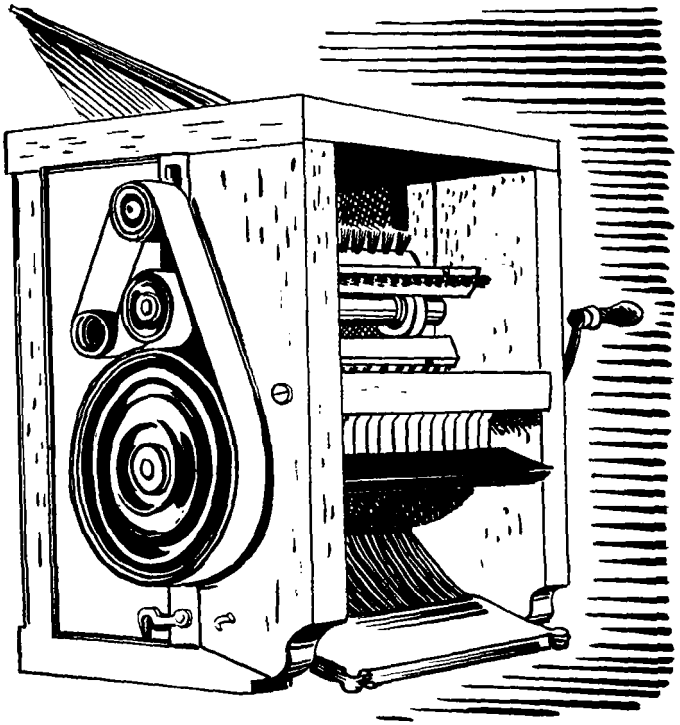
ELI WHITNEY was born on a farm near Westboro, Massachusetts in 1765. He began to show signs of genius in mechanical things when very young. When he was only 12 he made a violin. People liked his workmanship so well they brought their violins to him to be repaired. At 14 he set up a shop for making nails and made it pay.

After attending Yale University, Eli made a trip to the South. By that time, spinning and weaving machinery had been introduced and with it came an increased demand for raw cotton. Hand labor was able to remove the seed from only a few pounds of cotton a day.

Eli's genius for invention was becoming known and the wife of a planter said to him, "Why don't you invent a machine to separate seed from cotton?"

Two weeks later, Eli's machine was ready. The Southerners immediately began calling it "gin"—which is short for *engine*. It was capable of doing the work of 50 slaves.

Before Whitney's invention, the United States exported a meager 138,000 pounds of cotton a year.



Eli Whitney's famous cotton 'gin — short for engine — made cotton cloth plentiful and cheap, greatly increasing its uses.

In 1800, we produced 35 million pounds and exported 18 million.

But before Whitney could get his machine patented someone broke into his shop and carried it away. Soon his "gin" was operating all over the Cotton Belt. Others made millions from his invention and he lost everything he had in lawsuits.

Never wholly discouraged, Whitney in 1798 secured the help of Thomas Jefferson in getting a contract to make 10,000 muskets for the United States.

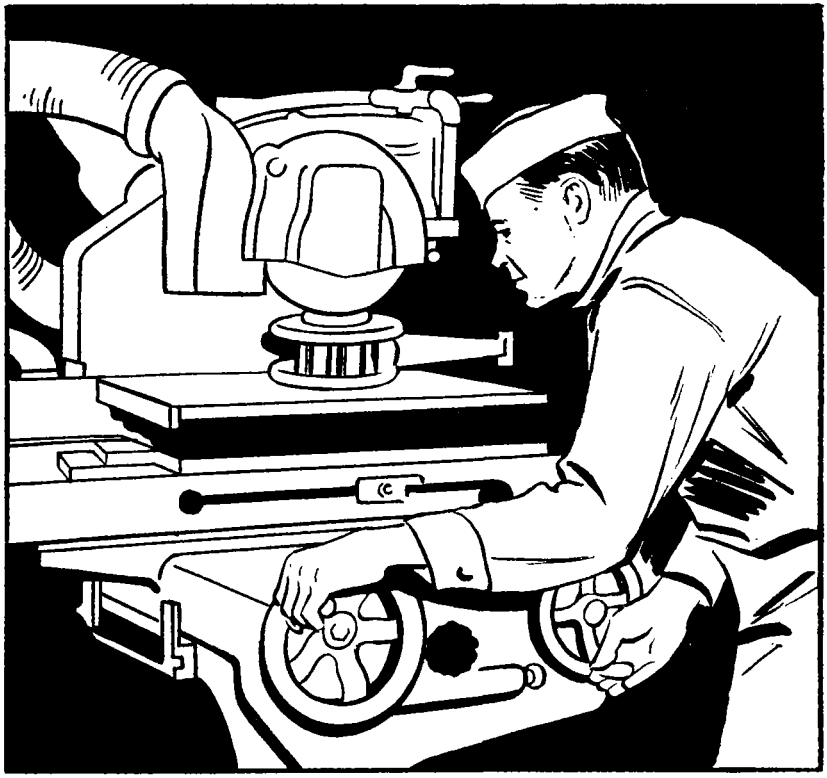
Up to that time, muskets were made by hand and the parts of one never matched the parts of another. Whitney believed that parts could be made so nearly alike, they would fit any gun in the ten thousand. Experts laughed at him.

Nevertheless he built a factory near New Haven, Connecticut, us-

ing a waterfall for power. He designed and built special jigs and fixtures and tooled up his machines so that he was able to obtain greater accuracy and more nearly identical parts than had ever been produced before. This took a lot of time. The government grew impatient.

Finally, two years later, Whitney appeared at the Capitol. He opened several boxes and placed ten gun barrels, ten triggers, ten stocks, and so on, in separate piles.

"Now," he told the experts, "pick any piece from any of these piles and lay them together."



This is a grinder, refinishing an aircraft engine master rod.

This was done. Whitney quickly assembled the parts into complete muskets. The scoffers were amazed, but convinced.

Since that time great strides have been made in design of machine tools and they have been set up to perform extremely accurate work, and Whitney's system of interchangeable parts has become the basis of all mass production. This system makes it possible to manufacture all sorts of mechanical devices at a price within reach of everyone.

For example, it would cost close to $20,000 to make one automobile by hand. At such a price not many people could afford to buy cars. This in turn would mean that many millions of people would not have jobs making, selling and servicing them.

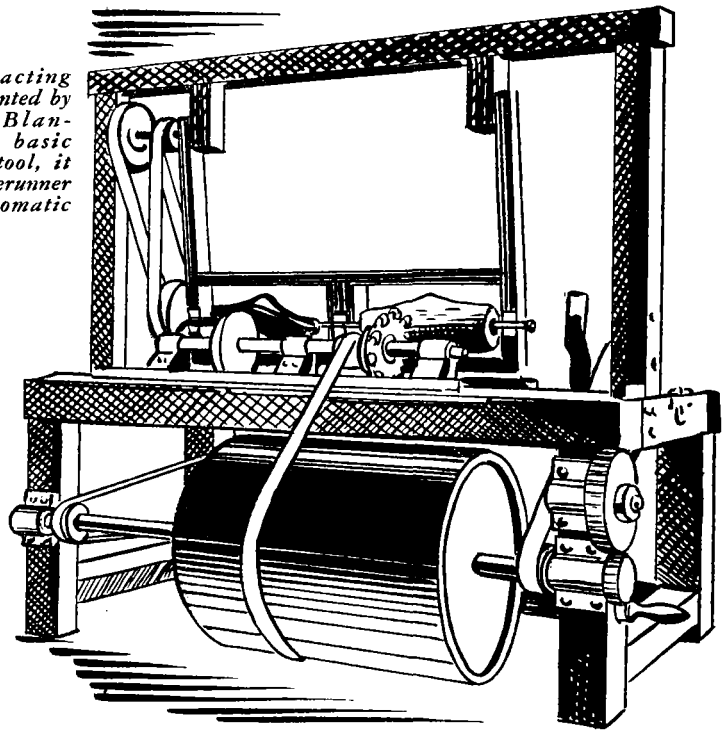
Mass production makes it possible for this country to produce 70 per cent of all the automobiles in the world, although our population is only six per cent of that of the world.

We also have 52 per cent of the world's telephones, 44 per cent of the world's radios and 30 per cent of the world's railroads.

Thomas Blanchard

An automobile engine has hundreds of parts. In some cases these parts must fit within one ten-thousandth of an inch, or "tolerances" ten times as fine as a human hair. A lathe is one of the many machine tools that help to turn out such parts with precision and accuracy. One of these, the form-turning lathe, was invented by Thomas Blanchard.

Thomas Blanchard was born in

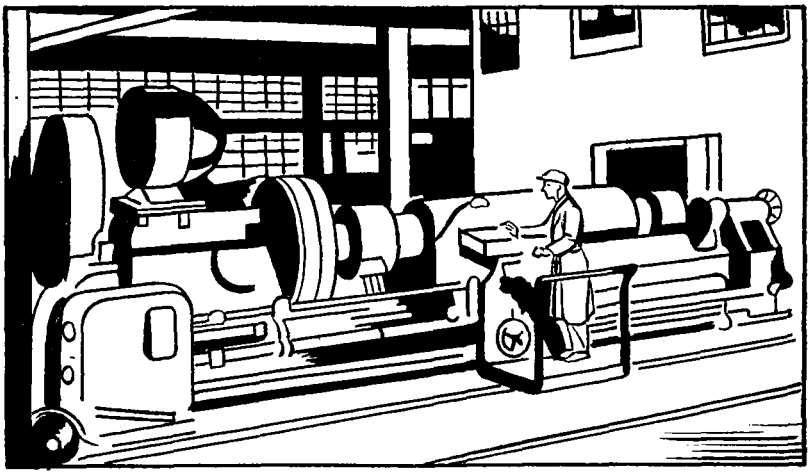


The self-acting lathe, invented by Thomas Blanchard. A basic machine tool, it was a forerunner of all automatic machinery.

1788 on a farm near Sutton, Massachusetts. He didn't like farm work and spent most of his time whittling small figures out of wood. He'd often whistle a monotonous tune, and when he talked he stuttered. People thought he was simple.

Thomas first showed his mechanical ability at 14 when he invented an apple parer that peeled apples 12 times as fast as they could be peeled by hand. He became popular at the "paring bees" which were common in those days.

He was first recognized as an inventor while working in his brother's tack shop. Tacks were made by hand, at little profit to the maker and at great expense to



Modern tool tailoring fits the machine to the workman. Here the operator "rides" on the platform attached to the tool carriage on a lathe built for grooving steel rolls.

the user. When his brother paid the meager wages of his 20 employees, he had hardly anything left. Thomas offered to make them with a machine.

"It takes a knack to make a tack. No machine can do it!", his brother objected.

Six years later Thomas perfected a machine that made 500 tacks a minute, and sold his patent for $5,000; a fortune in those days.

Like Eli Whitney, he got an order to make muskets for the government. More speed and accuracy were needed to turn out the barrels, which were cylindrical on one end and oval in shape on the other. Blanchard wanted to make a machine that would do this in one operation.

He spent day and night thinking about this lathe and whistling his monotonous tune.

One day he was riding in a carriage when suddenly the idea for the lathe came to him. "I've got it!", he cried out. Startled passengers thought he was crazy.

The time came when Blanchard needed a second renewal of his patent for the lathe and protection against pirating. To get it he made small wooden copies of sculptures of Henry Clay, John Calhoun and Daniel Webster, famous and in-

fluential men in the government. In 1840 he invited them to the Capitol to see his copies and the lathe that made them, and the renewal was granted.

Besides turning out gun stocks and barrels, the lathe machined lasts for shoes, tool handles and wheel spokes and made articles longer or shorter, right or left hand. It was one of the most remarkable inventions of the time.

Meanwhile, the other four basic machine tools — machines for removing metal by milling, grinding, planing, and drilling—were being developed to the requisite degree of accuracy. All modern machine tools are adaptations of combinations of these early cutting principles. Machine tools now constitute the larger share of productive equipment in our country's factories and make precision parts for everything from orange squeezers to airplanes.

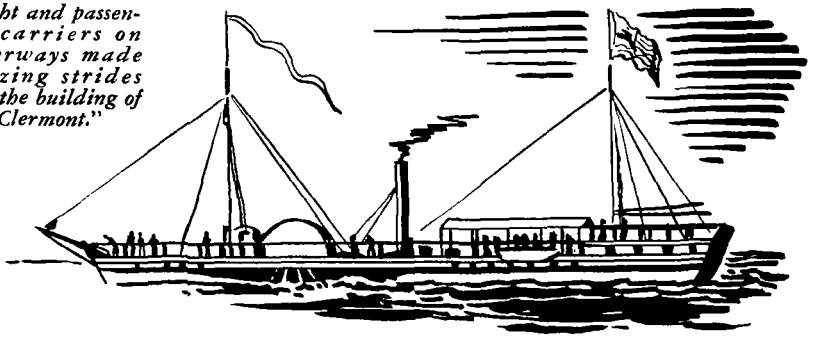
Robert Fulton

WHEN ROBERT FULTON WAS only 17 he was already recognized as a portrait painter in Philadelphia. However, he is best known as the first man to build a successful steamboat.

Fulton was born in 1765 near Lancaster, Pennsylvania. At 14 he equipped a heavy fishing boat with paddle and wheels which turned with a crank. In 1806 he began building the "Clermont" in New York.

Others, among them John Fitch, had started work some years earlier in attempts to build steam-powered boats. Fulton himself disclaimed credit for the invention of the steamship. But whether or not it actually was the first steamship, as it has come to be generally accepted, the "Clermont" was the first to be operated successfully.

Freight and passenger carriers on waterways made amazing strides with the building of the "Clermont."



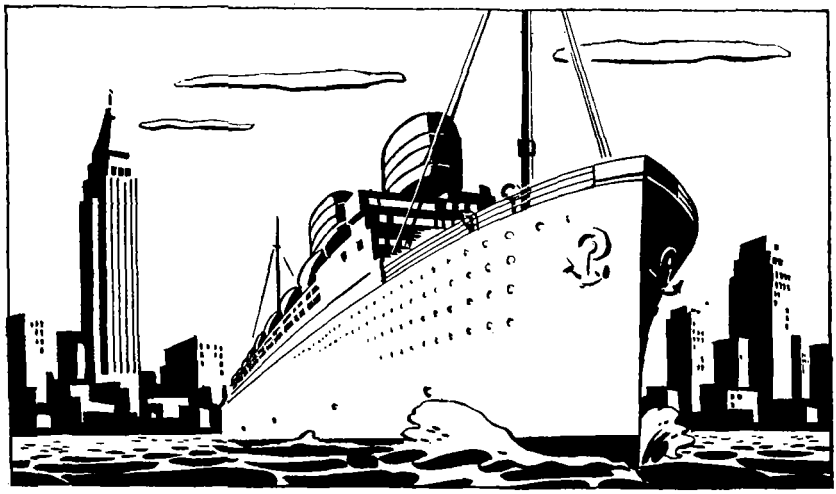
On August 17, 1807, when the *Clermont* was ready for its first voyage, people came from all over to jeer it. They were so fearful of the "puffing demon," Fulton could get only twelve passengers aboard.

"Want us to be blasted to bits?", people asked.

As if in reply, its tall, black, ungainly smokestack belched smoke and sparks, its machinery gave forth an unearthly growling and rumbling. Nevertheless, seven-foot paddle wheels frothing, the "puffing demon" moved into the Hudson.

The crowd was amazed. The scoffing stopped. So did the *Cler-*

Modern liners are self-contained cities. They have introduced Americans and American goods to every port and harbor on the globe.



mont. Then the scoffing took up where it left off.

"I told you so. I knew it wouldn't work!", the crowd chorused.

Fulton righted a gadget. The *Clermont* started up again, and 32 hours later arrived in Albany 150 miles away. The steamboat had proved itself a success.

Now Fulton ran into fresh difficulties. Competitors operated below cost to drive him off the river. They paid men to join his crews and wreck his machinery, then spread word that the *Clermont* was unsafe. But Fulton continued to build steamboats. By 1815 he had 17 in operation.

The *Clermont* was enlarged, offering "de luxe service." No one was allowed to lie down in the berths "with their boots and shoes on." The fine for violating this rule was $1.50; "50c extra for every half hour."

Steamers made two to six trips where sailing ships had made one. Trips that had taken weeks now took days.

When this knowledge got around, villages and towns along our seacoasts, rivers, and the shores of our Great Lakes began to see themselves as important shipping centers. This led to the building of ships' engines, docks, canals, locks and breakwaters that amazed the world. Like every great mechanical invention, the steamboat created a vast number of new jobs, crafts, skills and trades.

George Stephenson

GEORGE STEPHENSON was born in 1781 near Newcastle, England. As a boy, he helped his father fire the boilers of an engine that pumped water out of a coal mine.

In those days coal was hauled from the mines in trams pulled by horses over wooden rails at three

miles an hour. They never travelled farther than 10 miles.

George dreamed of long hauls to distant markets, at speeds faster than the fastest race horse. He made up his mind to become an engineer, but he had no education. His father needed him at the mine to help support a large family. George was 18 before he entered school. Little pupils would giggle when he couldn't spell "c-a-t." This made him terribly embarrassed, but it also made him determined to put in every spare moment studying, especially steam engines.

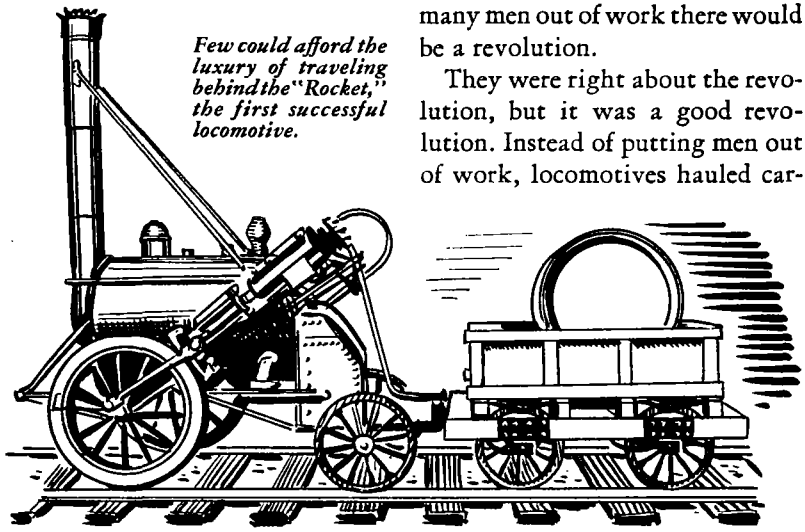
One day the engine at one of the neighboring coal mines broke down and none of the engineers could fix it. George did, and the manager made him enginewright.

In 1821 he made a successful trial trip between Stockton and Darlington with three locomotives he built. One day he told his son: "You will see the day when railroads will become great highways."

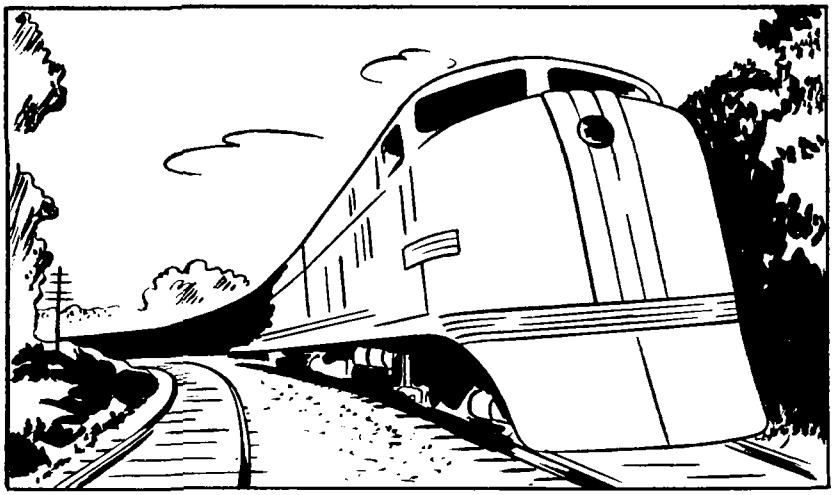
Soon after this, promoters planned a railroad from Manchester to Liverpool with a prize for the best locomotive. Out of four entries Stephenson won with his "Rocket," at a top speed of 29 miles an hour.

But people couldn't see as far ahead as Stephenson did. Railroads frightened them. Many thought that railroads would throw so many men out of work there would be a revolution.

They were right about the revolution, but it was a good revolution. Instead of putting men out of work, locomotives hauled car-



Few could afford the luxury of traveling behind the "Rocket," the first successful locomotive.



Today millions travel in comfort on our modern streamliners at a few cents a mile, across mountains and deserts, over rivers and great gorges.

goes of raw materials to distant mills and factories. They created new frontiers, causing villages, towns and cities to spring up where they had no reason to take root before. New industries, jobs, crafts and trades were started. These would not have been possible without this fast transportation.

Up to 1869 it took mule-team caravans six months to haul merchandise from Kansas City, Missouri to Santa Fe, New Mexico. A load worth $3,000 in Missouri cost $15,000 by the time it reached Santa Fe. During that period our government needed transportation so badly, it bought a herd of camels to carry this cargo across the desert.

Railroads have cut transportation costs to a level that makes tropical fruits, like oranges, grapefruit and bananas from California, Florida and South America, available the year round at reasonable prices.

In 1944 railroads in the United States moved 70 per cent of our total freight over 226,800 miles of tracks and provided work for nearly one and a half million people.

George Stephenson was right. Railroads have become the great highways of the world.

Francis M. Lechner

ONE DAY IN 1877, Joseph A. Jeffrey, connected with the Commercial National Bank in Columbus, Ohio, was passing a store and saw in the window an exhibition of a model of a coal cutter. The inventor was Francis M. Lechner, who had put it there hoping to interest someone in financing its development and manufacture.

Jeffrey was interested, and examined the model closely. The machine was designed to undercut coal previous to blasting, taking the place of laborious hand picking.

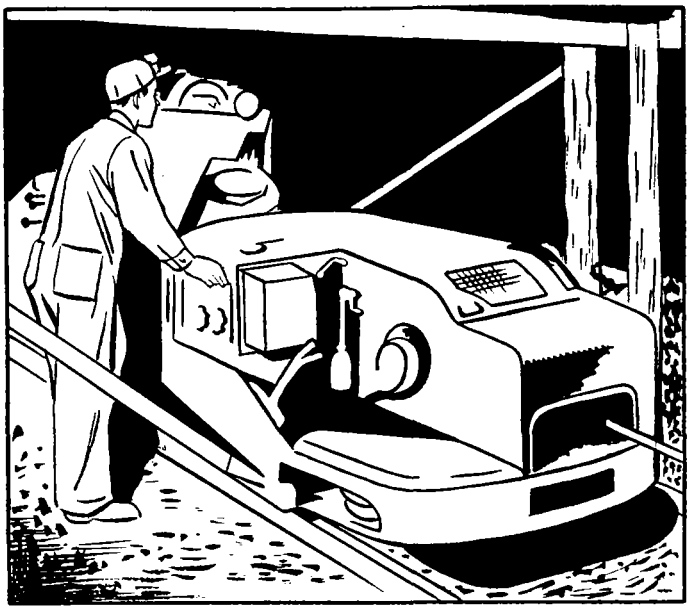
Jeffrey was convinced that the idea was a very good one. He organized the Lechner Mining Machine Company.

That original machine, however, was not very sturdy. Working well with soft coal, it went to pieces in the hard coal mine, but the inventors kept on improving it, though for a while it was constantly on the road between the mine and the repair shop.

To add to this difficulty, Lechner and Jeffrey had to meet the opposition of miners. The machine was calculated to ease their burdens. One of the toughest jobs in mining was hand picking. The miner was forced to lie on his side and wield a pick in that position. The miners, however, refused to see any advantage in the machine, and deliberately wrecked it. The machine had to be watched day and night in the New Straitsville, Ohio mine, where it was first introduced, to prevent its destruction.

It was ultimately a success after Jeffrey's engineers made necessary improvements. They developed a single machine that undercut, knocked down, and loaded coal into the mine car in one operation. Eventually electricity was substituted for other forms of power to operate these machines.

The new techniques raised the standard of working and living conditions in the mines. Mechan-



Francis Lechner's coal cutter has been developed into mining machinery that can cut the entire width of a room with one sweep of the cutting bar.

ized mines provided more employment than mines unable to adopt new techniques. Mining by machinery cut costs so that a greater amount of coal could be produced and sold more cheaply, and the market was broadened.

Mines which did not adopt the machinery had a hard time surviving.

Today about 80% of the mines are mechanized.

In recent years, $400,000,000 has been spent to install mining machinery.

Our coal-producing capacity is 600,000,000 tons a year. The demand for coal is practically limitless.

Coal produces 60% of the total mechanical energy, 65% of the electrical energy, and 90% of the energy for rail transportation.

It takes 1500 pounds of coal to produce one automobile; 2000 pounds to produce a tractor.

The mechanization of the mines was not easily accomplished. Machines, miners claimed, would hamstring mining. When loading machinery and undercutting were introduced, riots and machine-wrecking were regular occurrences.

Let's look at the truth.

Employment in coal mines in 1890 was 318,204 men. By 1944, in spite of the rapid development of oil and gas as fuels, it was 474,891.

Christopher Sholes

CHRISTOPHER SHOLES, known as the "Grandfather of Office Machinery," was born in Mooresburg, Pennsylvania in 1819. In early youth he was apprenticed to a printer in Milwaukee.

Christopher often watched the office people sitting at their high benches laboring over their books and records with quill pens. He noticed that the ink often faded, that copies were seldom made, and business records were in poor condition. He began to see hand writing as unnecessary drudgery and made up his mind to end it.

In 1867 he invented the typewriter.

That first typewriter was crude and bulky. The keyboard was made of black walnut wood with letters and numbers painted white. The

The first typewriter, invented by Christopher Sholes, cost $250 apiece to make. Few were sold until precision and accuracy in making parts increased production.

type spaced unequally and often stuck. But crude as it was, it had all of the basic features of the typewriters of today.

Sholes needed money to manufacture his typewriter, so he wrote letters on it to anyone and everyone he thought might be interested in backing it. One of these letters caught the attention of James Densmore, a capitalist of Meadville, Pennsylvania, who bought a fourth interest in the machine without seeing it.

The first machines cost $250 apiece to make. Sholes and Densmore realized that this cost would have to be drastically reduced if they were ever to be widely used. Not being machinists, they took their typewriter to a gunsmith. He told them: "This must be built

with the same accuracy and precision as firearms."

The machine was taken to the Remington Arms Company of Ilion, New York. In 1874 it was put on the market.

The machines did not come into wide use until after 1882. Then the mimeograph was developed, which made it possible to turn out typewritten copy in great quantities.

The mimeograph alarmed the printers. They were sure it would put them out of business.

Actually, the reverse was true. The typewriter made ideas easy to put down on paper. The need to share these products of mind and imagination resulted in more booklets, magazines and pamphlets, making more work for the printers, and producing copy easy to read.

Penmen and bookkeepers also worried about their jobs. They, too, were mistaken.

The electrical typewriter, which responds to the slightest pressure of the fingertips.

The smooth-running, lightning-swift machinery that grew out of the typewriter created more jobs and took away only the drudgery.

Before the invention of the typewriter, three out of every one thousand persons did office work. In 1940, with the addition of machines that add, subtract, multiply, divide, and even sign checks, over 38 persons out of every thousand did office work.

Most modern office machinery was introduced between 1920 and 1930. During that period, the number of stenographers and typists increased from 615,000 to 811,000, and of bookkeepers and accountants from 735,000 to 931,000.

Ottmar Mergenthaler

OF THE MANY operations in printing when granddad was a boy, the hand-setting of type was the most expensive. Inventors worked constantly to make a machine which would do the job quickly and cheaply.

In 1876, one of these "inventions" was brought into the shop of August Hahl in Baltimore, maker of scientific instruments.

Hahl took one look at it and summoned his assistant, Ottmar Mergenthaler, who had come to him from Wurttenburg, Germany.

"Ottmar, this monstrosity is supposed to be a printing machine, but no one can make it work."

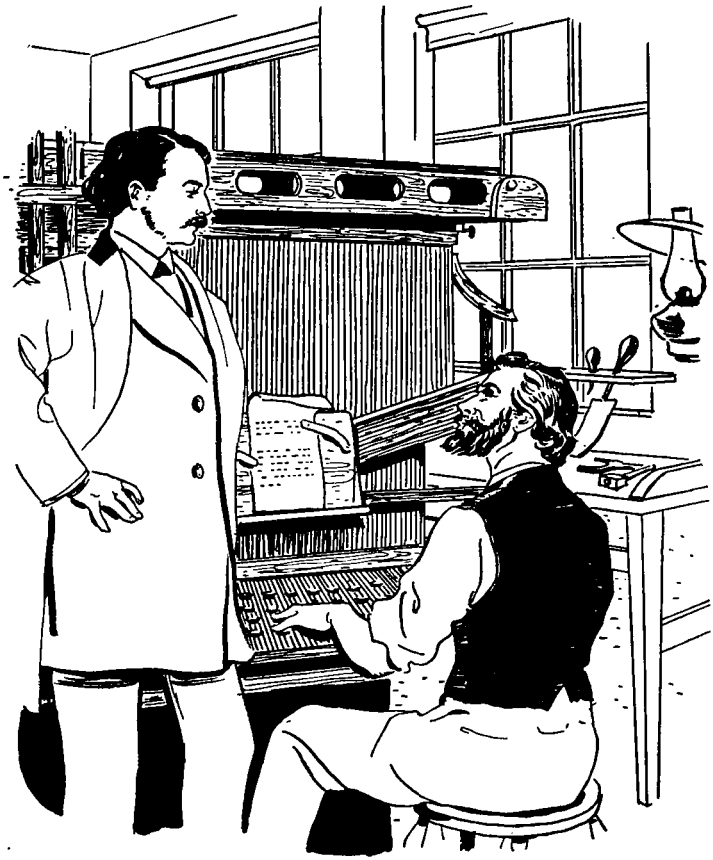
Ottmar looked it over and found it to be complicated. In the end, it had no advantage over hand-typesetting.

"Let me re-make it," said Ottmar.

On a July night in 1886, Mergenthaler's own printing machine was set up in the composing room of the *New York Tribune*.

For the first time in history, a machine was to set type for a newspaper.

Whitelaw Reid, the publisher, christened the machine "Linotype" because it set one line of type at a time. He turned the switch. Em-



Type was first set on a machine by Ottmar Mergenthaler in July, 1886, in the composing room of the New York Tribune, as Whitelaw Reid, the publisher, looked on.

ployees gathered around, and watched breathlessly as the machine started up.

"It acts almost human," someone whispered.

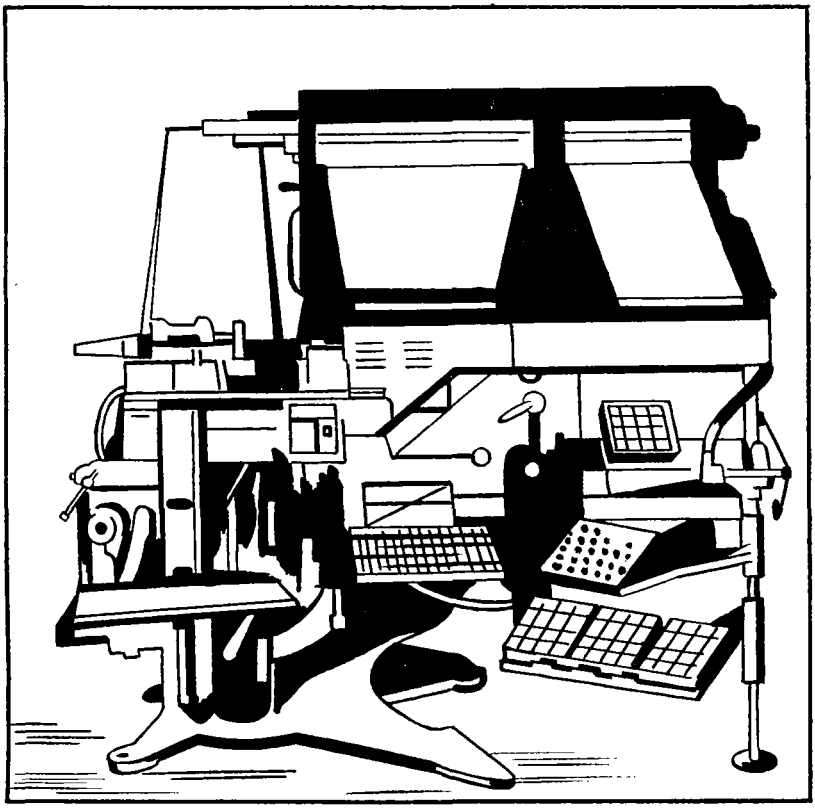
Next morning, readers of the *Tribune* read the first news ever printed with type set by a machine.

Many workmen who had set type by hand feared the loss of

their jobs. This was a mistake.

The introduction of linotype reduced the cost of printing so radically that fine works of literature, textbooks and popular and technical periodicals could be bought at prices within everybody's reach. Newspapers increased in size and circulation to such an extent that, although one linotype could do the work of four men, the total of all workers in the printing, publishing, and allied trades increased from 335,496 in 1910 to 683,237 in 1940.

A modern linotype. Precision manufacture of parts has made the linotype available to printers and publishers throughout the world.



John Butler Tytus

OUR EARLY AUTOS were horseless copies of the surrey, without the fringe on top. After a while "side curtains" were added, but they offered little protection from rain, wind, snow and cold. Designers finally had to enclose auto bodies in sheet steel.

About this time, sheet steel was also badly needed for washing machines, vacuum cleaners, electric refrigerators and other modern conveniences. But steel sheets were not being produced fast enough because steel was still being rolled by hand.

Long before this, in 1904 John Butler Tytus was watching the hot mill crews at the American Rolling Mill in Middletown, Ohio, and he noted with particular interest that each billet was handled 22 different times and with much lost motion before it became sheet steel.

Tytus, a graduate of Yale University, born in Middletown in 1875, had been working in his father's paper mill. He got to wondering why steel couldn't be rolled continuously, like paper. He had an idea it could. So he applied for a job in the rolling mill.

He was hired as a "spare hand." The work was hard and the hot iron seared his soft, white hands, but they became hard and calloused,

and he learned much about rolling sheet steel that could be learned in no other way. The workmen liked and respected him, and he worked constantly on plans for a continuous sheet mill.

It was 1923 before his mill was completed in Ashland, Kentucky. It was full of defects. Rolls broke and sheets buckled, so he had to continue his experiments three years longer before the mill was a success.

Within 10 years, 27 continuous wide-strip mills sprouted from that first mill in Kentucky. Manufacturers of autos, refrigerators and washers were now getting the sheet steel they needed.

Steel improved in quality, working hours in the mills became shorter, wages higher, and employment increased. At the same time, everything made from steel could be bought more and more cheaply.

Where in 1919 Americans bought

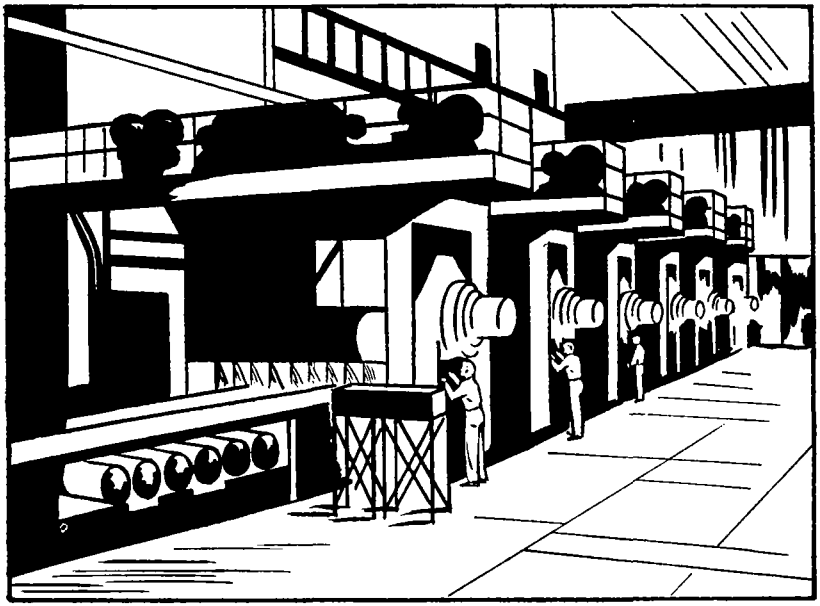
This was the kind of labor John Butler Tytus' continuous sheet mill ended.

1,600,000 cars, 90% of them open, at an average of approximately $1,100, in 1929 they bought 4,140,000, 90% closed, at an average of approximately $850.

By reducing the cost of sheet steel, Tytus made possible the economical production of countless devices, such as automatic toasters, electric refrigerators, washing machines, and so on, in the production of which sheet steel is an important element. Millions of men and women find gainful employment in making and selling them.

Yet some people would still refer to Tytus' mill as a "monster throwing men out of work." One day when a visitor to his office made a remark to this effect, Tytus lifted a tiny, silver-plated replica of the rolling mill from his desk and asked: "Did you ever try your hand at the kind of work it ended?"

The miniature mill had been presented to him by the men from whose backs he had lifted the burden of the hard way.



This is the continuous sheet steel mill.

WHAT IS TRUE of these ten great inventions is true of other machines; they create jobs.

Between 1870, which began the Machine Age, and 1940, the population in America rose 231 per cent; the number of persons with jobs rose 249 per cent.

Machines have shortened hours, raised wages, and made it possible to manufacture the things we need for our standard of living at prices that people can afford to pay.

Machines make life easier for everyone. They do the work and remove strain. They call for greater specialization. That gives workers a chance to use more mind and less muscle and to develop new skills. It makes them masters of the machine — operators, inspectors and supervisors.

In past years people were not always able to see how much inventions would benefit them.

That's just as true today. We hope these stories will remind us that what is to be is greater than we can see; and that wonderful opportunities for better jobs and better living still lie ahead of us.

A tool is but the extension of a man's hand, and a machine is but a complex tool. And he that invents a machine augments the power of a man and the well-being of mankind.

—Henry Ward Beecher